Marine and Coastal Safety and Security Infrastructure for the New Arctic Marine Highway

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As the climate warms, there is likely to be a nearly ice-free Arctic in this century. Already we are seeing extremely low sea ice extent in the winter, particularly in the Bering Strait and Chukchi Sea, as well as later freeze-up dates in the fall, thus paving the way for longer – and potentially riskier - Arctic navigation seasons. The U.S. and other nations such as Russia, China, Korea, and Japan are eyeing increased access and use of this new Arctic Marine Highway for shipping, offshore oil and gas and mining activities, commercial fishing and competition for subsistence activities and indigenous food security and other interests. For that reason, the marine waters and coastlines of the Beaufort, Chukchi and Bering Seas, which comprise the entirety of the U.S. Arctic, makes this region of great importance to national and international security. The U.S. Arctic in Alaska needs a robust marine and coastal observing infrastructure to support national interests in this region.

Similar to many regions of the world that lack power, easy road access and robust communication systems, the Alaska Arctic is a challenging environment for obtaining sustained observations, especially in real-time. However, the need exists for this information for forecasting and reporting on ocean conditions to improve navigation safety, assessing and planning for risks and incident response, and responding to coastal hazards such as longer periods of mobile ice and increased impacts of waves and storms on coastlines and communities. The Alaska Ocean Observing System (AOOS), the Alaska regional component of the national Integrated Ocean Observing System (IOOS), has partnered with the Bureau of Ocean Energy Management, the University of Alaska, the National Weather Service, the Marine Exchange of Alaska and the Arctic Domain Awareness Center to demonstrate new observing technologies and infrastructure support data products and applications that address this need. AOOS and partners are delivering real-time surface current, sea ice, water level and weather data in areas which were off limits 10 years ago, supporting high performance data computing, integration and synthesis to generate new data products and decision-support tools, and engaging with the stakeholders who will use and benefit from them. Some examples are described here that could be used in other remote regions of the Arctic.

High Frequency (HF) radars & remote power modules: Since 2009 during ice-free seasons, shore-based HF radars have been used to record real-time hourly surface currents by processing the Doppler spectrum from transmitted radar waves backscattered by ocean waves along the Chukchi and Beaufort coasts. For the past five years, these power-hungry radars have been sustained by remote power modules developed by the University of Alaska Fairbanks for remote, “off-the-grid” use. The coverage capability varies with sea ice cover, calm sea conditions, and/or ionospheric interference (see www.aoos.org/hfradar). The products can be used operationally for sea state conditions, search and rescue operations, navigation and oil spill response. Data are also crucial inputs into circulation models and forecasts.

X-band radars have been operating continuously since 2007 in Utqiaġvik (formerly known as Barrow) to monitor near-shore ice conditions (up to approximately 20 km or 11 nautical miles) and evaluate the stability of landfast sea ice. Images are recorded every 4 minutes and are sent via internet to the University of Alaska, where they are processed to derive maps of ice velocity, divergence and convergence. Local subsistence hunters and analysts at the National Weather Service's Anchorage Ice Desk have regularly used the sea ice radar to assess ice conditions in the Utqiaġvik area. Commercial and civilian mariners use the imagery and animations for navigational purposes when mobile sea ice poses a potential threat to their vessels.

Wave buoys measure and transmit data on surface currents, waves and sea surface temperatures – all critical data for safe navigation, and validating models and forecasts. Season sea ice has restricted use of wave buoys in the past, although seasonal deployments have occurred in the Bering Strait and Chukchi Sea. With longer periods of ice-free seasons, usage of these buoys becomes more realistic, with a new buoy planned outside the Port of Nome in summer 2018.

Real-time ice observations are typically restricted to seasonal mooring operations that can only be conducted with a ship during ice-free conditions. However, it is exactly during the breakup and freeze-up transitions when observations are most needed for accurate ice forecasting and modeling efforts. An ice detection buoy system has been piloted for two seasons recently to provide real-time temperature and salinity data throughout the water column running up to the day of freeze-up or use by sea ice forecasters. The mooring remains in the water without recovery while the surface buoy detaches on command at freeze-up, allowing this system to remain in place throughout the freeze-up process. With increased ship traffic, deployment of these buoys becomes increasingly realistic, and could significantly lengthen the period of real-time ocean observations during the late fall and early winter in the Arctic.

Accurate water level observations are fundamental for storm-surge forecasting, informed emergency response, ecosystem management, safe navigation, and mapping and charting. Alaska's extensive and remote shorelines are especially under-instrumented for water level observations, limiting Alaska's ability to provide useful marine forecasts and leaving exposed coastal populations and infrastructure. This is in part because of obstacles including seasonal ice, lack of coastal infrastructure and rapid coastal erosion, all which render conventional water level sensing technologies inapplicable. AOOS is piloting the use of water level/GPS receivers to measure water levels at accuracy levels necessary for computing principal tidal constituents (+/- 5 cm), estimating tidal datums, and providing observations needed to improve storm surge and inundation forecasts. These systems are low-maintenance, power-stingy, and easier and less expensive to install and maintain compared to traditional water level gages.

Weather forecasters and mariners alike are benefitting from numerous Automatic Identification System (AIS) stations across Alaska, now equipped with weather sensors that report localized wind conditions alongside vessel tracking information. These stations could be further enhanced to report local subsistence activity or other community observations to vessels transiting nearby. AOOS is working with the Marine Exchange of Alaska to develop a historic database of vessel traffic data providing a synthesis, archive, and display of a variety of associated decision-support tools. The goal is to enhance usability of this increasingly valuable dataset for analyzing potential oil spill impacts from vessel groundings and collisions, risk management measures, subsistence use avoidance, and planning and prioritization for hydrographic surveys.